Roll No:
(To be filled in by the candidate)

PSG COLLEGE OF TECHNOLOGY, COIMBATORE - 641 004

SEMESTER EXAMINATIONS, APRIL - 2013

BE / BE(SW) - PRODUCTION ENGINEERING   Semester: 4

08P401   FLUID MECHANICS AND MACHINERY

Time: 3 Hours   Maximum Marks: 100

INSTRUCTIONS:

1. Group I and Group II questions should be answered in the Main Answer Book.
2. Answer any **FIVE** questions in Group II.
3. Answer **ALL** questions in Group I and Group III.
4. Group III − **Multiple Choice questions** - (which will be given to the candidates half an hour before the scheduled close of the examination) **should be answered only** in the space provided **in the Main Answer Book.**
5. **Moody's Chart, Fluid properties table and Minor loss coefficient tables** is permitted.

GROUP I   **Marks: 10 x 3 = 30**

1. What are the circumstances under which a fluid can be treated as a continuum?

2. A flow is described by the velocity field, $V = a\bar{i} + bx\bar{j}$, where b = 1/s and a = 2 m/s. Coordinates are measured in meters. Obtain the equation of the streamline passing through the point (2, 5). Symbols are as per standards.

3. When a glass is slowly filled with water to the maximum possible level, it can be observed that the level of water can be above the rim of the glass. How can it be higher than the rim of the glass?

4. Illustrate the condition of incomplete similarity with an example.

5. The velocity distribution for laminar flow in a long circular tube of radius R is given by the following one-dimensional expression.

$$V = u\vec{i} = u_{max}\left[1 - \left(\frac{r}{R}\right)^2\right]\vec{i}$$

    For this profile, obtain an expression for the volume flow rate.

6. The three components of velocity in a velocity field are given by u = Ax + By + Cz, v = Dx + Ey + Fz and w = Gx + Hy + Jz. Determine the relationship among the coefficients A through J that is necessary if this is to be a possible incompressible flow field.

7. What is the significance of relative roughness of the pipe on the frictional loss in a laminar flow?

8. Define boundary layer thickness.

9. Sketch the flow around a fish swimming in water and a smooth ball in flight. Comment on the wake region for these cases.

10. What is the importance of net positive suction head?

GROUP II   **Marks: 5 x 12 = 60**

11. A Pelton wheel has a mean bucket speed of 10 m/s with a jet of water flowing at the rate of 700 litres/s under a head of 30 m. The buckets deflect the jet through an angle

of 160°. Calculate the power supplied to the runner and the hydraulic efficiency of the turbine. Assume the co-efficient of velocity as 0.98.

12. A block of mass M slides on a thin film of oil. The film thickness is h and the area of the block is A. The same is shown in figure 1. When released, mass m exerts tension on the chord, causing the block to accelerate. Neglect friction in the pulley and the air resistance. Derive and solve a differential equation for the block speed as a function of time.

13. Water enters a tank of diameter D_T steadily at a mass flow rate of $\dot{m}_{in}$. An orifice at the bottom with diameter D_o allows water to escape as shown in figure 2. The orifice has a rounded entrance, so the frictional losses are negligible. If the tank is initially empty, determine the maximum height that the water will reach in the tank and obtain a relation for water height z as a function of time.

14. An oil pump is drawing 35 kW of electric power while pumping oil with ρ = 860 kg/m³ at a rate of 0.1 m³/s. The inlet and the outlet diameters of the pipe are 8 cm and 12 cm respectively. If the pressure rise of oil in the pump is measured to be 400 kPa and the motor efficiency is 90%, determine the mechanical efficiency of the pump. Take the kinetic energy correction factor to be 1.05. Neglect the elevation difference across the pump.

15. At a large fish hatchery the fishes are reared in open, water filled tanks. Each tank is approximately square in shape with curved corners, and the walls are smooth. To create motion in the tanks, water is supplied through a pipe at the edge of the tank. The water is drained from the tank through an opening at the centre. A 1:13 scale model is to be used to determine the velocity V at various locations within the tank. Assume that V = f ($\ell, \ell_i, \rho, \mu, g, Q$) where ℓ is some characteristic length such as tank width, ℓ_i represents a series of other pertinent lengths such as pipe diameter, fluid depth etc., ρ is the fluid density, g is the acceleration due to gravity, Q is the discharge through the tank. Determine the suitable set of dimensionless parameters. If water is to be used for the model, can all of the similarities be satisfied? Support the answer with suitable calculations. If the flow rate into the full sized tank is 950 L/min, determine the model discharge assuming Froude number similarity. What model depth will correspond to a depth of 80 cm in the full sized tank?

16. a) List the various methods to control the boundary layer separation. With neat sketches explain any two of these methods. (8)
    b) It is quite a common sight that a bicyclist leans forward and brings his upper body and knees closer during a race. What is the reason for him to do so? (4)
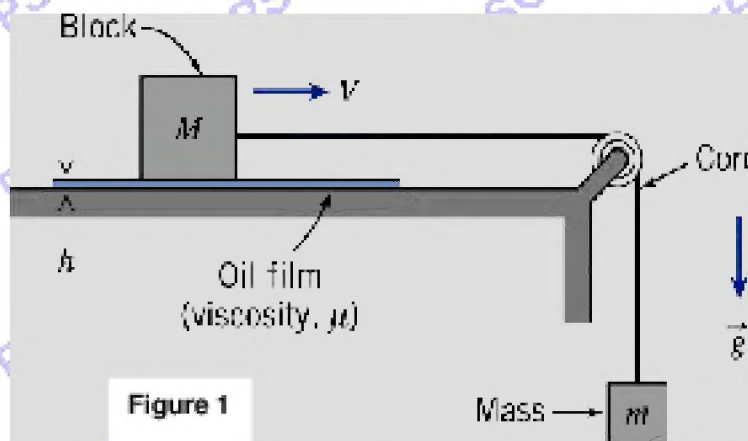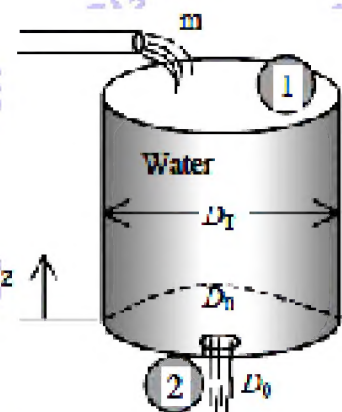

Figure 1

Figure 2

Roll No:

> Write the Alphabet of your choice answer for each question in the space provided in the Main Answer Book
> (Do not attach this question paper along with the Main Answer Book)

APRIL – 2013

08P401   FLUID MECHANICS AND MACHINERY

GROUP III   Marks: 10 x 1 = 10

I)   An open tank contains brine to a depth of 2 m and a 3-m layer of oil on top of the brine. Density of brine is 1,030 kg/m^3 and the density of oil is 880 kg/m^3. The gage pressure (kPa) at the bottom of the tank is most nearly

A) 46.1   B) 4.7   C) 20.2   D) 25.6

II) The figure shows two cylinders of diameter D and 2D, connected to each other and containing an incompressible fluid. The two cylinders are fitted with leak-proof pistons of weight W_1 and W_2 as shown. Which of the following is a correct expression?

A) $W_2 = W_1 / 2$

B) $W_2 = 4 W_1$

C) $W_2 = W_1$

D) $W_2 = 2 W_1$

III) The figure shows the relationship between shear stress and velocity gradient for two fluids, A and B. Which of the following is a true statement?

A) Absolute viscosity of A is less than that of B

B) Kinematic viscosity of A is greater than that of B

C) Kinematic viscosity of A is less than that of B

D) Absolute viscosity of A is greater than that of B
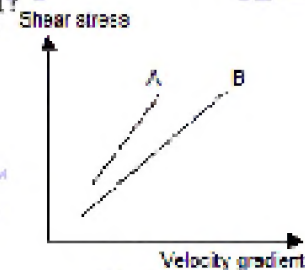
IV) A 50.8 mm diameter cylinder is floating vertically in seawater with 75% of its volume submerged. If the specific gravity of seawater is 1.03, the specific weight (N/m^3) of the cylinder is most nearly

A) 7357   B) 7578   C) 8320   D) 7315

V)   At a certain section in a pipeline, a reducer is used to reduce the diameter from 2D gradually to diameter D. When an incompressible fluid flows through this pipeline, the velocity is U_1 in the first section and U_2 in the second section. Which of the following is a true conclusion?

A) $U_2 = 4U_1$ B) $U_2 = 2U_1$ C) $U_2 = U_1 / 2$ D) $U_2 = U_1 / 4$

VI) When a Newtonian fluid flows under steady, laminar condition through a circular pipe of constant diameter, which of the following is NOT a correct conclusion?

A) The shear stress at the centerline of the pipe is zero

B) The maximum velocity at a section is twice the average velocity at that section

C) The velocity gradient at the centerline of the pipe is zero

D) The velocity will decrease along the length of the pipe

VII) The figure shows a horizontal pipeline with a sudden enlargement. The energy grade line and the hydraulic grade line under a certain flow of an incompressible fluid are also shown. The ratio of the diameter downstream to the diameter upstream of the enlargement is most nearly

A) 1.68

B) 1.50

C) 1.26

D) 2.50
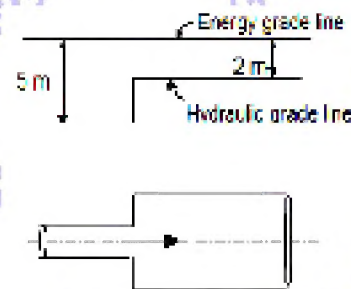
VIII) Which of the following is a non-dimensional grouping where, F is a force; ρ is the density; A is the area; and U is a velocity?

A) $\dfrac{F}{\rho AU}$ B) $\dfrac{F}{\rho A^2 U}$ C) $\dfrac{F}{\rho AU^2}$ D) $\dfrac{F}{\rho^2 AU}$

IX) Braking jet in an impulse turbine is used

A) to bring the runner to rest in a short time
B) to break the jet of water
C) to change the direction of the runner
D) to change the direction of the jet

X) Draft tube converts large portion of kinetic energy of water flowing through it into

A) potential energy   B) pressure energy
C) mechanical energy   D) kinetic energy